

## PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

SHAYA, Darrin, Maurice  
Black & Decker  
210 Bath Road  
Slough SL1 3YD  
ROYAUME-UNI

Date of mailing (day/month/year) 09 November 2001 (09.11.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference GER 5355 (WO)	
International application No. PCT/GB00/01727	International filing date (day/month/year) 05 May 2000 (05.05.00)

1. The following indications appeared on record concerning:		
<input type="checkbox"/> the applicant	<input type="checkbox"/> the inventor	<input type="checkbox"/> the agent <input type="checkbox"/> the common representative
Name and Address	State of Nationality	State of Residence
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:		
<input checked="" type="checkbox"/> the person	<input type="checkbox"/> the name	<input type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence
Name and Address BRÖHL, Reinhold Daubringer Strasse 7 35460 Staufenberg Germany	State of Nationality DE	State of Residence DE
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
3. Further observations, if necessary: The person appearing in Box 2 above has now been recorded as an additional applicant/inventor for the US only.		
4. A copy of this notification has been sent to:		
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned	
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned	
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:	

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer R. Chrem
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

## PATENT COOPERATION TREATY

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From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

To:

SHAYA, Darrin, Maurice  
Black & Decker  
210 Bath Road  
Slough SL1 3YD  
ROYAUME-UNI

Date of mailing (day/month/year) 09 November 2001 (09.11.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference GER 5355 (WO)	
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1. The following indications appeared on record concerning:		
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Name and Address	State of Nationality	State of Residence
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:		
<input checked="" type="checkbox"/> the person	<input type="checkbox"/> the name	<input type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence
Name and Address SCHMIDT, Wolfgang Kopernikusweg 5 35447 Reiskirchen Germany	State of Nationality DE	State of Residence DE
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
3. Further observations, if necessary: The person appearing in Box 2 above has now been recorded as an additional applicant/inventor for the US only.		
4. A copy of this notification has been sent to:		
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned	
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned	
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:	

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer R. Chrem
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

## PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

## NOTIFICATION RELATING TO PRIORITY CLAIM

(PCT Rules 26bis.1 and 26bis.2 and  
Administrative Instructions, Sections 402 and 409)

To:

SHAYA, Darrin, Maurice  
Black & Decker  
210 Bath Road  
Slough SL1 3YD  
ROYAUME-UNI

Date of mailing (day/month/year) 04 December 2000 (04.12.00)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference GER 5355 (WO)	
International application No. PCT/GB00/01727	International filing date (day/month/year) 05 May 2000 (05.05.00)
Applicant EMHART INC. et al	

The applicant is hereby **notified** of the following in respect of the priority claim(s) made in the international application.

1. ☒ **Correction of priority claim.** In accordance with the applicant's notice received on: 03 August 2000 (03.08.00), the following priority claim has been corrected to read as follows:

DE 05 June 1999 (05.06.99) 199 25 628.4

- ☐ even though the indication of the number of the earlier application is missing.  
☐ even though the following indication in the priority claim is not the same as the corresponding indication appearing in the priority document:

2. ☐ **Addition of priority claim.** In accordance with the applicant's notice received on: , the following priority claim has been added:

- ☐ even though the indication of the number of the earlier application is missing.  
☐ even though the following indication in the priority claim is not the same as the corresponding indication appearing in the priority document:

3. ☐ As a result of the correction and/or addition of (a) priority claim(s) under items 1 and/or 2, the (earliest) priority date is:

4. ☐ **Priority claim considered not to have been made.**

- ☐ The applicant failed to respond to the invitation under Rule 26bis.2(a) (Form PCT/IB/316) within the prescribed time limit.  
☐ The applicant's notice was received after the expiration of the prescribed time limit under Rule 26bis.1(a).  
☐ The applicant's notice failed to correct the priority claim so as to comply with the requirements of Rule 4.10.

The applicant may, before the technical preparations for international publication have been completed and subject to the payment of a fee, request the International Bureau to publish, together with the international application, information concerning the priority claim. See Rule 26bis.2(c) and the PCT Applicant's Guide, Volume I, Annex B2(1B).

5. ☐ In case where **multiple priorities** have been claimed, the above item(s) relate to the following priority claim(s):

6. A copy of this notification has been sent to the receiving Office and

- ☐ to the International Searching Authority (where the international search report has not yet been issued).  
☒ the designated Offices (which have already been notified of the receipt of the record copy).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer  Maria Victoria CORTIELLO
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
 US Department of Commerce  
 United States Patent and Trademark  
 Office, PCT  
 2011 South Clark Place Room  
 CP2/5C24  
 Arlington, VA 22202  
 ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

<b>Date of mailing</b> (day/month/year) 16 February 2001 (16.02.01)	
<b>International application No.</b> PCT/GB00/01727	<b>Applicant's or agent's file reference</b> GER 5355 (WO)
<b>International filing date</b> (day/month/year) 05 May 2000 (05.05.00)	<b>Priority date</b> (day/month/year) 05 June 1999 (05.06.99)
<b>Applicant</b> KRENGEL, Michael et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

21 December 2000 (21.12.00)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was  
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland  Facsimile No.: (41-22) 740.14.35	Authorized officer  Zakaria EL KHODARY  Telephone No.: (41-22) 338.83.38
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(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
28 December 2000 (28.12.2000)

PCT

(10) International Publication Number  
**WO 00/78495 A1**

(51) International Patent Classification<sup>7</sup>: **B23K 9/20**

Klaus, Gisbert [DE/DE]; Alicenstrasse 22, D-35390  
Giessen (DE).

(21) International Application Number: **PCT/GB00/01727**

(74) Agent: **SHAYA, Darrin, Maurice**; Black & Decker, 210  
Bath Road, Slough SL1 3YD (GB).

(22) International Filing Date: **5 May 2000 (05.05.2000)**

(25) Filing Language: **English**

(81) Designated States (*national*): AE, AL, AM, AT, AU, AZ,  
BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK,  
DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL,  
IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU,  
LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT,  
RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA,  
UG, US, UZ, VN, YU, ZA, ZW.

(26) Publication Language: **English**

(30) Priority Data:  
199 25 628.4 **5 June 1999 (05.06.1999)** **DE**

(71) Applicant (*for all designated States except MG, US*):  
**EMHART INC.** [US/US]; Drummond Plaza Office Park,  
1423 Kirkwood Highway, Newark, DE 19711 (US).

(84) Designated States (*regional*): ARIPO patent (GH, GM,  
KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent  
(AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent  
(AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU,  
MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM,  
GA, GN, GW, ML, MR, NE, SN, TD, TG).

(71) Applicant (*for MG only*): **BLACK & DECKER EU-  
ROPE** [GB/GB]; 210 Bath Road, Slough SL1 3YD (GB).

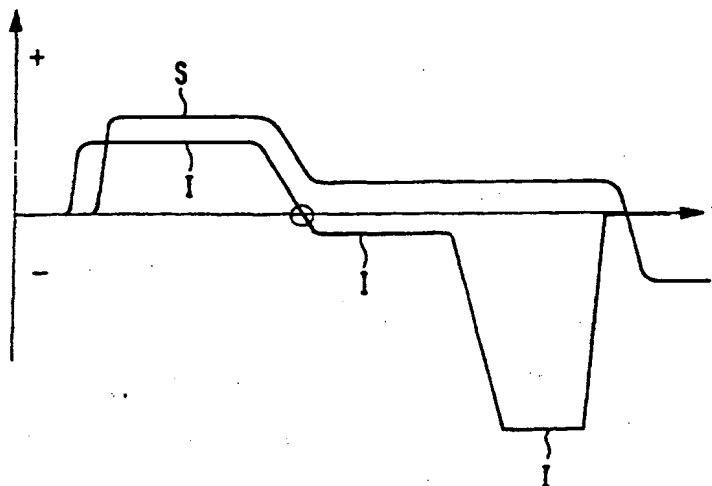
Published:  
— *With international search report.*

(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **KRENGEL,**  
Michael [DE/DE]; Giessener Strasse 123, D-35396  
Giessen (DE). **GOTTWALS, Haymo** [DE/DE]; Her-  
mannsbergweg 6, D-35325 Mücke (DE). **SCHMITT,**

*For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.*

(54) Title: **LIFT-AND-STRIKE WELDING PROCESS WITH CLEANING STAGE**



(57) Abstract: The present invention relates to a lift-and-strike welding process. In a first step, e.g. an aluminium surface (5) of a component is cleaned by striking an arc and then the element (4) to be connected is welded on by means of at least one second voltage. Besides a lift-and-strike welding apparatus, a further lift-and-strike welding process is also provided, wherein an electric cleaning current flows between a surface (5) of a component and an element to be welded thereon, in that the component rests on the surface (5) and then the element (4) is lifted off the surface (5) up to an approximately, in terms of time, constant distance for removing a coating from the surface (5) by means of an arc, then the current changes its polarity, wherein afterwards at least one welding current is produced and then the element (4) is welded to the surface (5).



**WO 00/78495 A1**

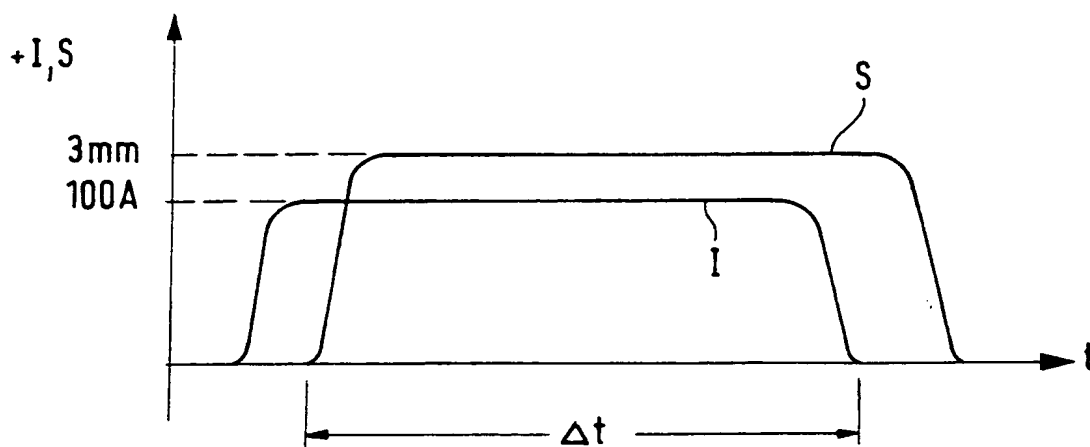


FIG.1

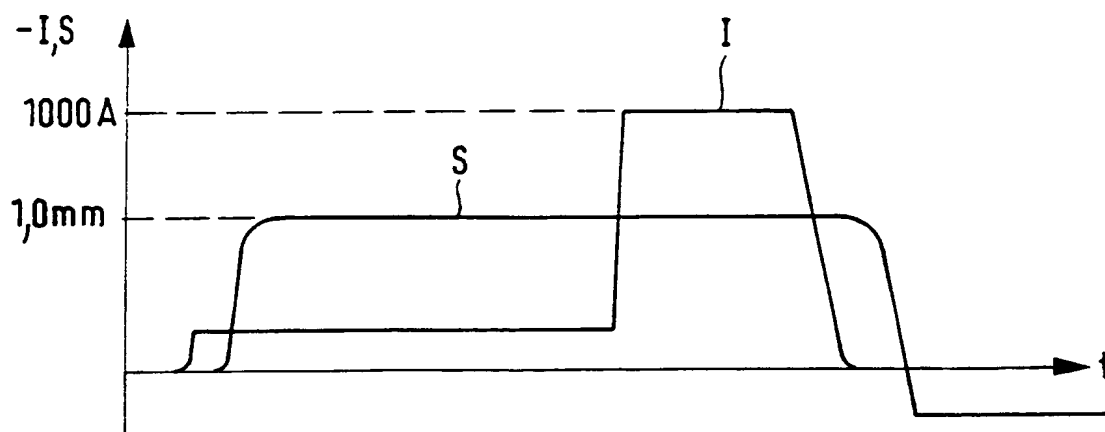
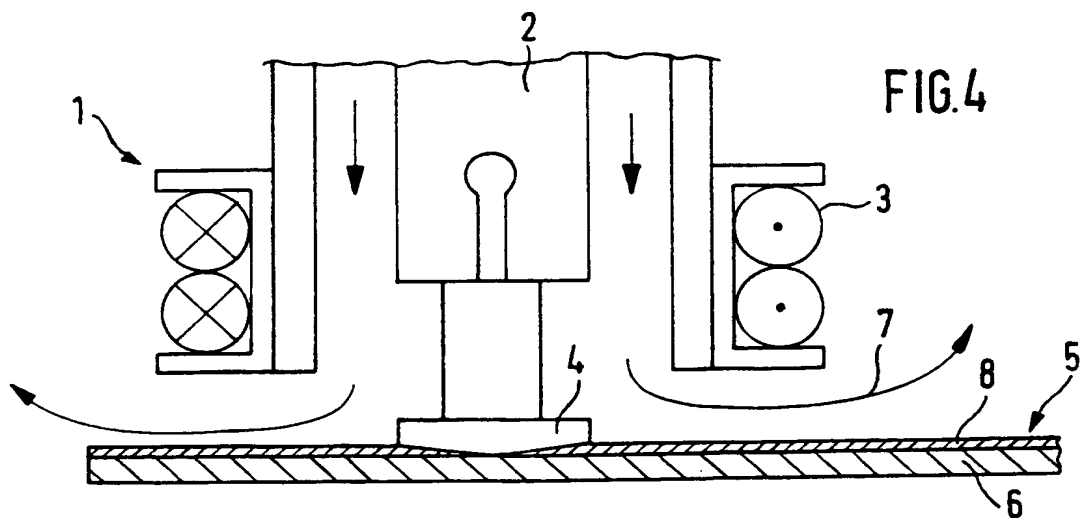
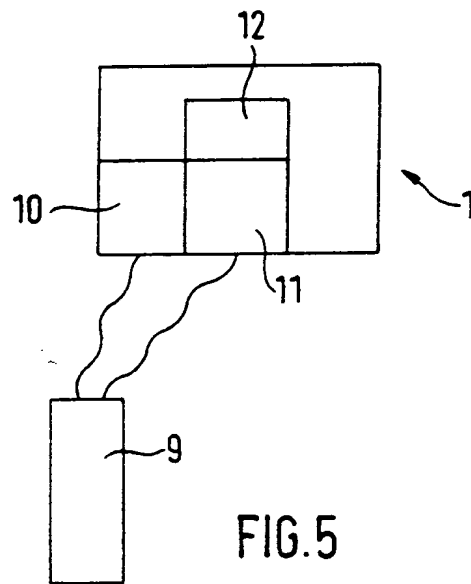
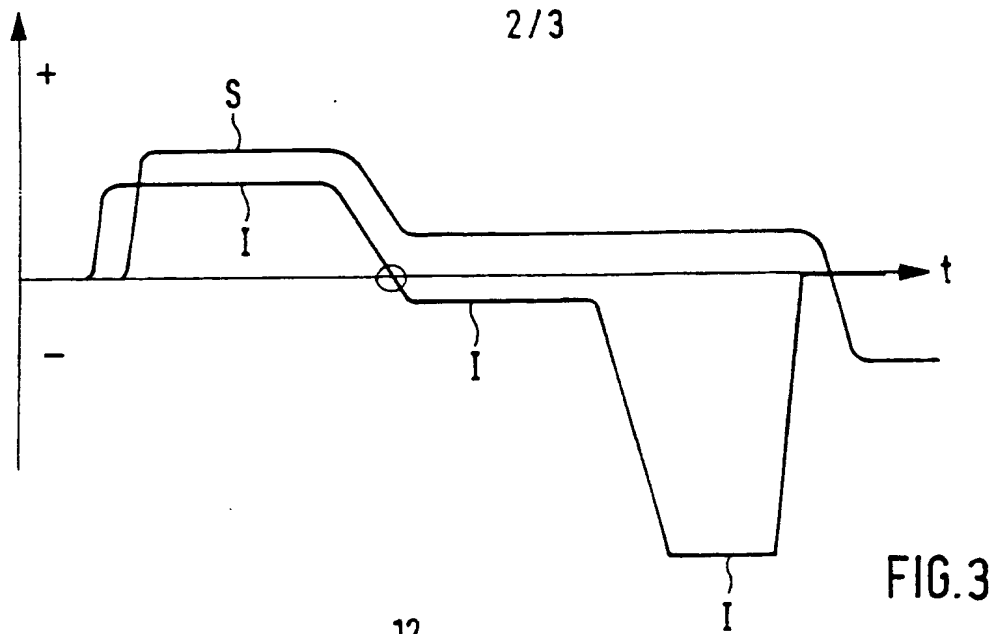


FIG.2



3/3

FIG.6

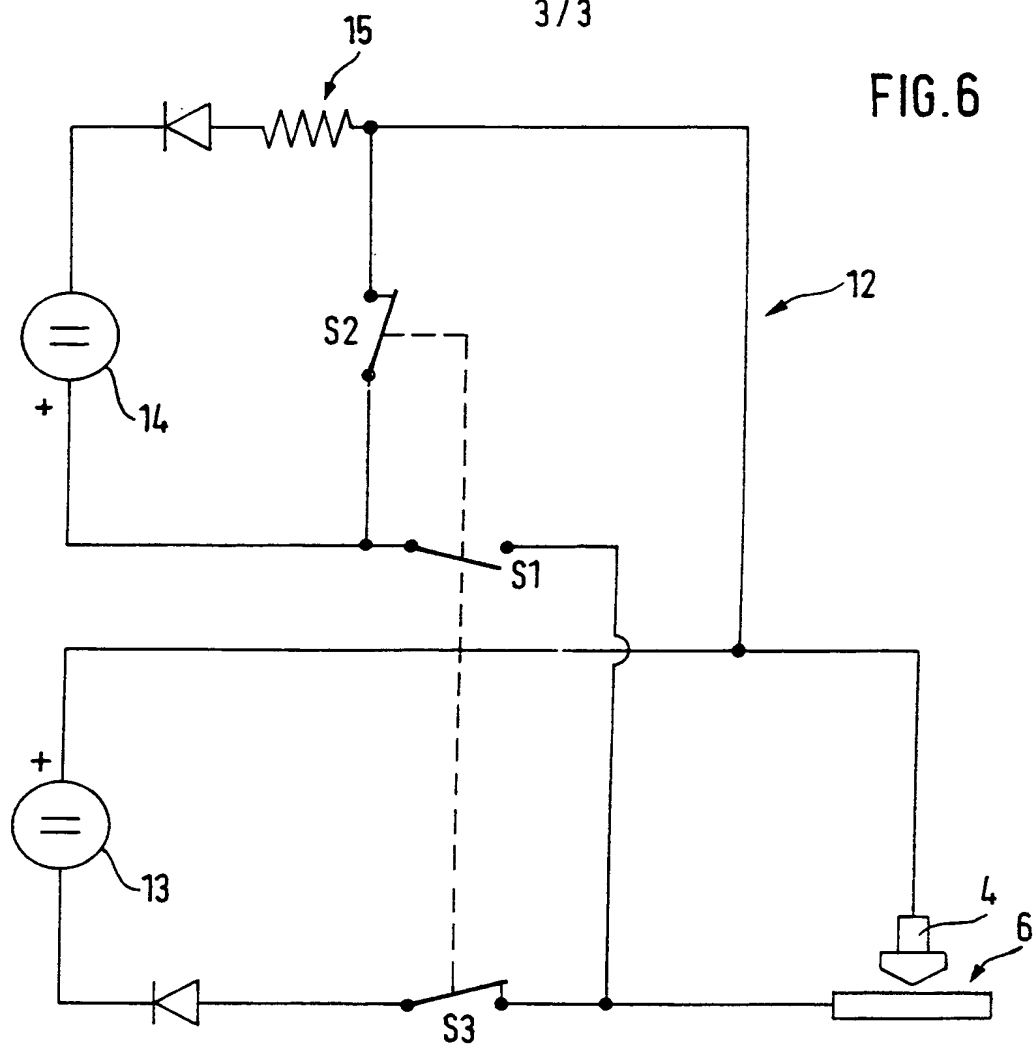
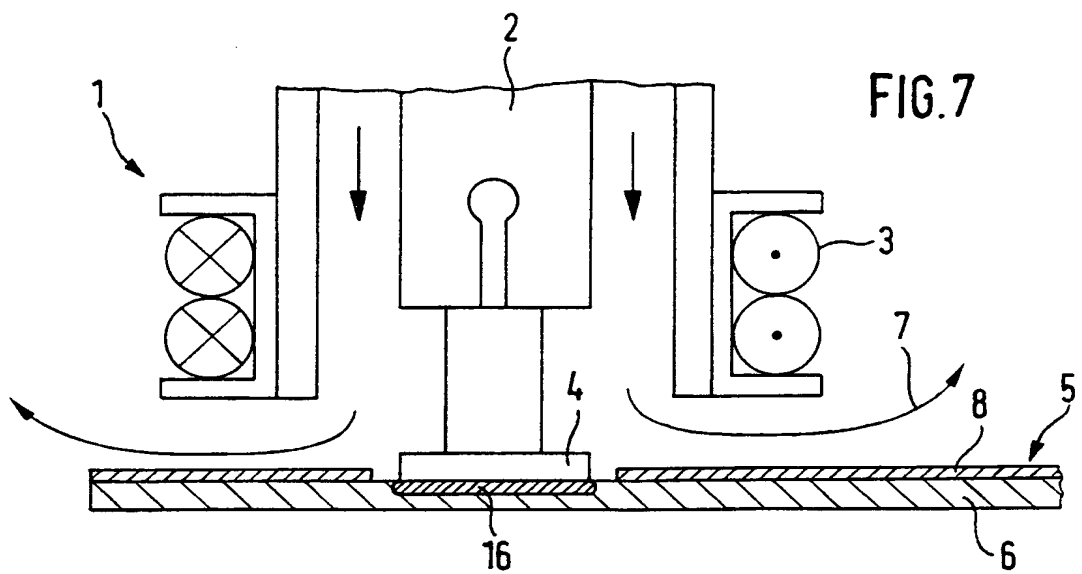


FIG.7





## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/01727

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B23K9/20

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X  A  A	DE 195 24 490 A (EMHART INC) 9 January 1997 (1997-01-09) cited in the application column 1, line 57 - line 60 column 3, line 42 - column 4, line 21 abstract; claims; figures ----- DE 43 13 502 A (BETTERMANN OBO OHG) 27 October 1994 (1994-10-27) column 4, line 38 - line 65 figure 7 -----	1-12, 15-18, 20-24 13, 14, 19        1-24

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

18 August 2000

Date of mailing of the international search report

25/08/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Haegeman, M

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/01727

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19524490 A	09-01-1997	US 5938945 A	17-08-1999
DE 4313502 A	27-10-1994	NONE	

## LIFT-AND-STRIKE WELDING PROCESS WITH CLEANING STAGE

The invention relates to a lift-and-strike welding process as well as to a lift-and-strike welding apparatus. The process and the apparatus are suitable in particular for welding a weld stud onto an aluminium surface or steel sheet surface, which have in each case a surface coating, e.g. a lubricant coating.

5

A lift-and-strike welding process, in particular a stud lift-and-strike welding process, has the advantage of industrial-scale capability combined with processing reliability with regard to, for example, reliable ignition of an arc. The lift-and-strike welding process is also less noisy than other welding processes. The lift-and-strike welding process is therefore used in numerous fields especially on account of its being economical to operate. Especially in the automobile industry, lift-and-strike welding has become an established technique. Aluminium and aluminium composite components are becoming increasingly popular as materials in the automobile industry on account of their low weight. From DE 195 244 90, for example, a lift-and-strike welding process is known, wherein an aluminium weld stud is welded to a workpiece made of aluminium. According to said process, a height of lift of the weld stud is varied in dependence upon a measured arc voltage. It is also known from said document that, to prevent a short circuit being caused by melted material dripping from the weld stud, a polarity at the weld stud or at the workpiece is reversed during the welding operation. It is also known that, by reversing the polarity, a formation of a molten bath is varied.

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The object of the present invention is therefore to provide a lift-and-strike welding process and a corresponding lift-and-strike welding apparatus, with which an element may be welded reliably and with a high quality onto a surface, even if a coating should be disposed on the surface.

25

Said object is achieved by a first lift-and-strike welding process having the features of claim 1 as well as by a second lift-and-strike welding process having the features of claim 7, by a lift-and-strike welding apparatus having the features of claim 15 as well as

by means of a polarity reversing means having the features of claim 20. Advantageous developments and refinements are indicated in the dependent claims.

5 A first lift-and-strike welding process is such that, as a first step, a surface of a component is cleaned, namely by applying a first voltage so as to strike an arc between an element to be connected to the surface, in particular a stud, and the surface. In a second step, a polarity of the first voltage is reversed. Then the element is welded on by means of at least one second voltage.

10 Said process is particularly suitable for use with steel sheets and aluminium sheets, which have an organic coating or are zinc-coated. The zinc coating may be electro-plated or galvanised or may be Bonazink. The coating may also consist of accumulated dirt or the like. For example it has proved particularly suitable to use the process for the welding of steel sheets having a sheet thickness of 1 to 0.5 mm and less which has a zinc  
15 protection layer, e.g. in the case of hot galvanising, of 70  $\mu\text{m}$  and less, e.g. also in the case of thin zinc protection layers, of 30 to 3  $\mu\text{m}$  or even less. The cleaning process is very precisely adaptable to the surface to be cleaned and is also suitable for very thin coatings. There now follows a detailed description of the mode of operation of the invention with reference to a machining of a component made of aluminium. The  
20 features described below are however also applicable to the welding of a corresponding steel component, in particular a steel sheet.

Aluminium components which are cold formed, in particular deep drawn, have a surface coating in the form of a lubricant. Said lubricant prevents cold welding between  
25 the aluminium workpiece and a machining tool. The lubricant moreover reduces the friction force which arises. An organic coating, in particular a wax or oil-based coating is often used. By striking an arc as a cleaning arc, the effect is achieved that the organically based coating as a result of overheating by the arc volatilises leaving no significant residues, in particular leaving no residue, and/or is displaced from the welding region.  
30 The subsequent actual welding operation by means of e.g. a pilot current and subsequent welding current of the lift-and-strike welding process allows the element, which is to be

welded on, to be dipped into a weld pool of the aluminium surface which is not contaminated with the previous coating.

For cold-formed aluminium sheets a wax-based lubricant coating is customary. During an arc welding process, the wax releases hydrogen which would bond with the molten aluminium during the welding operation. The moment the molten aluminium hardens again, the ability of the aluminium to bond with the released hydrogen is lost. The hydrogen is exhaled and leaves behind a high porosity in the region of the joint zone. Said porosity leads to an enormous deterioration of the welding quality. Through use of the aluminium lift-and-strike welding process it is possible to avoid a poor welding quality. The process also allows its users to dispense with previous cleaning of the aluminium components used. Cold deep-drawn sheets, for example, prior to subsequent welding previously had to be sent through a washing lane in order to prepare the surface of the aluminium sheets for the welding process. Said cleaning operation is now no longer necessary. As a result, aluminium-containing components having a coating may even without basic preliminary cleaning be reliably welded e.g. with a weld stud. The quality of the weld joint therefore depends on the ambient conditions in the joint zone which are created by the cleaning arc, wherein the surface is advantageously rendered dry and metallically pure.

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It is advantageous when, after the first step of applying the cleaning voltage, in a second step a polarity of the first voltage is reversed. By said means the cleaning may be influenced by altering the arc. It is further advantageous when, after the first voltage used as a cleaning voltage has dropped, the actual lift-and-strike welding process ensues after a specific period of time. The process is improved by reversing the polarity between the first and subsequent second voltage. Said reversal is effected preferably in the period of time, during which the first voltage has dropped, in particular to zero. In said case, during the cleaning phase a positive polarity is preferably adjusted for the first voltage. This means that at the aluminium surface of the component there is a negative potential, while the weld-on element has a positive potential. It is therefore possible to heat the aluminium sheet up to temperatures at which the coating is volatilised. The aim is in particular to clean a region of the surface which, for example, approximately

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corresponds to, or is optionally slightly smaller or slightly larger than, the subsequent joint zone. Given use of a weld stud, the aim is to achieve a circular cleaned surface having a diameter which preferably corresponds to the diameter of the weld stud. Given a different geometry of the weld-on component, e.g. an oval or angular cross section, the cleaned surface is advantageously of a corresponding size. This is assisted by a polarity of the type described above. For the subsequent welding operation a negative polarity is preferably selected. A negative polarity during the cleaning operation might give rise to the problem of rust particles arising and/or remaining in the region of the surface to be cleaned.

10

The first voltage is moreover preferably set higher, in terms of its magnitude, than the immediately following voltage of reverse polarity. It is set, for example, by appropriate adjustment of the height to which the weld-on element is lifted above the surface. By increasing the distance, the voltage may likewise be increased while the current intensity, for example, remains constant. This enables a requisite energy density to be produced for the cleaning operation while, e.g. given use of a subsequent pilot current for the lift-and-strike welding process with reverse polarity, the aluminium surface is heated up and the arc stabilised in such a way that a weld pool of suitably required depth is produced when the subsequent welding voltage is applied.

20

The application of a first cleaning voltage may be effected separately from a subsequent application of a pilot welding voltage. For reversal of the polarity of the arc, it is advantageous when the polarity is reversed when the first voltage reaches a zero value. For said purpose, the zero value is advantageously maintained for a short time. Said voltage-free time is provided, for example, when the weld-on element is being moved in the direction of the surface. It is only after said time that a second voltage, e.g. a pilot voltage, is built up. For said purpose, the weld-on element is situated, after the cleaning operation, back in contact with the surface. By lifting the element off the surface, the welding arc e.g. in the form of a pilot arc is then ignited. Said machining steps are however preferably combined with one another. As a result, the machining time of a component is reduced. According to a development, said time reduction is achieved in that a drop of the first voltage is immediately followed by the welding process

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preferably using a pilot voltage and subsequent welding voltage, wherein the last two voltages have a different polarity to the first voltage. In said manner, a reliable ignition of the arc after the polarity reversal is possible.

- 5           The possibility moreover exists of applying the welding voltage directly after the first voltage and the subsequent polarity reversal.

A second aluminium lift-and-strike welding process is further provided. Said process may, for example, be combined with the first aluminium lift-and-strike welding  
10   process. The second aluminium lift-and-strike welding process comprises the following steps:

- an electric cleaning current flows between an aluminium surface of a component and an element to be welded thereon, in that the component rests on  
15   the aluminium surface and then the element is lifted off the aluminium surface up to an approximately, in terms of time, constant distance for removing a coating from the aluminium surface through ignition of an arc as a cleaning agent,
- then the current changes its polarity, wherein afterwards at least one welding  
20   current is produced and
- then the element is welded to the aluminium surface.

The particular effect realised with said process is that during reversal of the  
25   polarity the current continues to flow between the surface and the element to such an extent that, despite the polarity reversal, the arc does not collapse. The element need not therefore be brought back into contact with the surface for ignition of the arc.

Preferably a cleaning current is used, which assumes a current intensity of between  
30   15 and 120 amperes, in particular 500 amperes, before it drops. Said cleaning current intensity is sufficient for complete removal of the coating, which is situated e.g. on one aluminium surface, by means of the arc. In said case, the duration of the cleaning

operation may be influenced by the level of the current intensity: the higher the arc current, the shorter the duration of the cleaning operation. The cleaning current intensity is however preferably set low enough to prevent a weld pool area from starting to form on the aluminium surface. The temperature is taken into account in such a way that there is, in particular, not yet any melting of material during the cleaning operation. This is simultaneously regulated or controlled e.g. likewise by the duration of the effective cleaning current intensity. It has moreover proved advantageous when after a reversal of the polarity an, in terms of its magnitude, maximum current is produced. Said current is then the welding current which ensures the formation at the aluminium surface of a weld pool of corresponding molten material, into which the element to be connected, e.g. an aluminium stud with a melted end face, is subsequently dipped. Preferably, the element is brought back into contact with the aluminium surface only after disconnection of the welding current. In particular, such a time delay is observed, that the weld pool has become doughy again but nevertheless still retains its bonding capacity.

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According to a development of the aluminium lift-and-strike welding process, the cleaning current lasts approximately as long as or longer, in particular at least 3 times longer, than a pilot current flowing prior to the welding current. It is further advantageous when the welding current is equal to or stronger, in particular at least 1.2 times stronger, than the cleaning current. The injection of power into the workpiece achieved in each case thereby is therefore appropriate to the respective objectives of the individual process steps. The maximum power injection is effected during the actual welding operation and a power injection for cleaning purposes, which is adapted to the respective coating of the aluminium surface, is accordingly lower.

25

The nature of the power injection may moreover also be regulated by means of the duration. This is dependent, on the one hand, upon the type of coating and, on the other hand, upon the thickness of the coating. In particular, the volatilising of the coating is recorded by a suitable apparatus and used as the basis for adjusting, e.g. regulating or controlling, a power injection by means of the cleaning current or the cleaning voltage. This also enables later evaluation of corresponding parameters of the cleaning operation for a subsequent quality inspection, e.g. while also taking into account parameters of the

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subsequent welding operation. Volatilising of the coating is measurable, for example, through a variation of the arc voltage or the current. Through measurement of a suitable parameter, the duration of the cleaning step may also be regulated so that, given a corresponding variation of the measured value, e.g. of the voltage, the cleaning operation  
5 is terminated, the polarity is reversed and the welding process ensues. When, for example, the surface is being cleaned to remove an organic coating containing hydrogen, a voltage drop of the arc voltage is to be observed once the hydrogen, which is to be removed, has been removed. A corresponding lift-and-strike welding apparatus therefore comprises, for example, a suitable measuring, regulating and/or control device which  
10 provides appropriate functions. Such an apparatus also comprises a suitable evaluation device e.g. with a suitable memory etc.

It has further proved advantageous when the element, during cleaning of the aluminium surface, assumes a distance from the aluminium surface which is at least 2  
15 times greater than the distance from the aluminium surface particularly when a pilot current flows prior to the welding current. It is therefore possible, on the one hand, to clean a larger area of the aluminium surface. On the other hand, the possibility exists of using a variation of the distance to adapt the intensity of the cleaning in accordance with the respective coating without having a negative effect upon the base material.

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Besides the previously described features, the measures for controlling and/or regulating the weld stud which are known from DE 195 244 90 are moreover also applicable for effecting the aluminium lift-and-strike welding process. In particular, it has proved advantageous to use, for welding-on, stud geometries of the type disclosed in  
25 DE 196 11 711. Express reference is hereby made to the respective technical teaching of both documents.

An aluminium lift-and-strike welding apparatus is further provided. The apparatus comprises a guide for a weld-on element and a control device for the guide. The guide is,  
30 for example, a welding head, a welding gun or a housing for fixing and lifting the weld-on element. The apparatus further comprises a device for controlling or regulating the electric current and/or the voltage used for welding, wherein the apparatus has a polarity

reversing means for the voltage used for welding. The device for controlling or regulating the electric current and/or the voltage is programmed or designed so as to produce, prior to the welding operation, a cleaning current which has a reverse polarity relative to the welding current. The apparatus may be used in particular to effect a process in accordance with the above description.

The invention further provides a polarity reversing means for a lift-and-strike welding apparatus. The polarity reversing means comprises a circuit element which produces an arc current during the reversal of the polarity, in particular in the form of a circuit acting as a reactor in order to maintain a struck arc during a reversal of the polarity of the arc voltage. The polarity reversing means advantageously comprises a first and a second power source, wherein the first power source supplies a cleaning current and the second power source supplies a welding current. A coil is advantageously connected to the first and the second power source in such a way that a struck arc continues to be maintained during reversal of the polarity. An extinction of the arc is therefore prevented when the current passes through zero.

Further advantageous refinements and developments as well as features of the invention are illustrated in greater detail in the following drawings, in which:

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Fig. 1 shows a characteristic of a distance  $S$  and of an electric cleaning current  $I$  in a first step of the lift-and-strike welding process,

Fig. 2 shows the characteristic of the distance  $S$  and of the electric current  $I$  in a welding step as a third step of the process,

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Fig. 3 shows a development in the form of a combination of the first step, a second step and the third step,

Fig. 4 shows an apparatus for implementing the process,

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Fig. 5 shows a sketch of the apparatus for implementing the process,

Fig. 6 shows a circuit diagram of a polarity reversing means and

Fig. 7 shows a stud welded on a sheet having a coating.

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Fig. 1 is a diagram illustrating a possible first step as a cleaning step of the process sequence of the welding process. A current intensity  $I$  and a distance  $S$  are plotted along the y-axis. The distance  $S$  is the distance between the weld-on element and an exemplary aluminium surface. The time coordinate is plotted along the x-axis. In the first step, the weld-on element is situated in contact with the aluminium surface. The current intensity  $I$  is switched on. A flow of current occurs between aluminium surface and the element. The cleaning current being injected is preferably adjusted to a magnitude of between 20 and 500 amperes. Said cleaning intensity is preferably held approximately constant also for a specific period of time. After a short time delay after switching on the current intensity  $I$ , the element is lifted off the aluminium surface and preferably moved up to an approximately constant distance  $S$ . The cleaning current intensity is kept constant and the arc voltage arises in accordance with the distance  $S$  and the degree of cleaning. The distance  $S$  is advantageously approximately 3 mm for an aluminium weld stud. After a duration  $\Delta t$ , which starts with lifting of the element from the aluminium surface and ends with the dropping of the cleaning current intensity to zero ampere, the aluminium surface is cleaned. The duration  $\Delta t$  is preferably set between 15 ms and 120 ms. The advantage of said cleaning is that the cleaned area remains limited at least to approximately the weld pool area subsequently required. When, for example, there is provided on the aluminium surface a coating which is to be retained also in the subsequent workpiece, e.g. a protective coating, the process offers the advantage of having removed the coating only in the region of the welding zone. The distance  $S$  is in particular adjusted in such a way that the arc which arises is focused on the aluminium surface and so the surface to be cleaned remains limited. Preferably, such a focusing of the arc is adjusted by means of a suitable guide for the weld-on element. Alternatively, the welding apparatus may have a suitable focusing device which is, for example, integrated with the guide. According to one construction of a suitable welding apparatus, use is made for said purpose of a guide comprising a collet, around which an a.c.-operated magnet coil is

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disposed. By said means it is possible to prevent a dispersion of the arc as a result of blowout. The first step is followed by the polarity reversal as a second step, which is not shown in detail.

5        Fig. 2 shows a third step of the process which comes after the first step of Fig. 1 and the second step, namely the subsequent polarity reversal. The polarity reversal is evident from the change of the sign of the current intensity. Preferably, a change from positive to negative occurs. According to a development, the weld-on element remains in the lifted position, e.g. 3 mm up, for a specific period of time. This allows any material  
10 of the aluminium surface and also possibly of the surface of the element itself which has already melted to harden again. For example, 10 to 80 ms, preferably up to 30 ms after disconnection of the current intensity, the lift e.g. by means of a coil is switched off and the element comes back into contact with the aluminium surface. From said point on, the third step in Fig. 2 begins. Reversal of the polarity from positive to negative in the  
15 second step is followed by the start of a lift-and-strike welding process of the type disclosed e.g. also by the already cited DE 195 244 90. For example, an arc is ignited by a pilot current, which provides for a stabilising of the welding current. For said purpose the weld-on element, which has been back in contact with the aluminium surface, is removed once more from the surface. According to the diagrammatic embodiment, the  
20 distance S then remains once more substantially constant. After a specific period, which lasts longer than the actual welding current duration, the pilot current is increased to a welding current, e.g. to 1000 amperes or more. During application of the welding current, the aluminium surface is melted to such an extent that an adequate pool depth is provided. After the welding current has dropped to 0 ampere, there is additionally a  
25 specific waiting period to allow the aluminium pool to become doughy. Only then is the element to be welded dipped into the surface and the weld joint produced. An implementation of the process in the manner shown in Fig. 1 and Fig. 2 has the advantage of a precisely predetermined pattern. By linking the steps to one another, the machining time is simply added up. This may lead to somewhat longer retention times in  
30 the machining station, e.g. of 300 ms and more. Said time is also dependent *inter alia* upon how much time the reversal of the polarity takes. The reversal preferably takes no longer than 200 ms. A development therefore provides that the first step of Fig. 1 and the

third step of Fig. 2 be combined with one another. This is explained in greater detail below.

Fig. 3 shows a combination of the first, second and third steps of Fig. 1 and Fig. 2 in the form of a combination of the process steps without contact of the weld-on element between cleaning and welding. A reversal of the polarity of the current is effected without the weld-on element in the meantime coming into contact with the aluminium surface. Rather, the cleaning current I is converted by reversal of the polarity into a pilot current of the welding process. Said reversal is effected by suitable adaptation of the decrease of the cleaning current intensity up to the passage through zero. After the passage through zero, the current intensity with a negative polarity, indicated by the minus sign in Fig. 3, is controlled or adjusted to a suitable current magnitude of a pilot current. Then the maximum welding current ensues. Compared to the individual steps as they emerge from Fig. 1 and Fig. 2, the machining time is only an insignificant amount, e.g. about 100 ms, longer than a conventional lift-and-strike welding process.

Tests have shown that, with the following values, particularly good welding results have been achieved for an aluminium surface in combination with an aluminium stud:

20	cleaning current intensity:	15-500 amperes
	cleaning period:	20-100 ms
	distance S for duration of cleaning	2.5-3.5 mm
	pilot current intensity:	15-25 amperes
	duration of pilot current intensity:	0-8 ms
25	distance S for duration of pilot current:	0.6-1.4 mm
	welding current intensity:	500-1500 amperes
	duration of welding current:	8-100 ms
	distance S for duration of welding current:	1.4 down to 0.6 mm

30 Fig. 4 shows the diagrammatic view of an apparatus 1 for implementing the lift-and-strike welding process. The apparatus 1 comprises a collet 2, around which a coil 3 is disposed. By means of the collet 2 a weld-on element 4, in the present case an

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/01727

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19524490 A	09-01-1997	US 5938945 A	17-08-1999
DE 4313502 A	27-10-1994	NONE	

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference <b>GER5355</b>	<b>FOR FURTHER ACTION</b>	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. <b>PCT/GB00/01727</b>	International filing date (day/month/year) <b>05/05/2000</b>	Priority date (day/month/year) <b>05/06/1999</b>
International Patent Classification (IPC) or national classification and IPC <b>B23K9/20</b>		
Applicant <b>EMHART INC.</b>		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 6 sheets, including this cover sheet.

- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand  <b>21/12/2000</b>	Date of completion of this report  <b>05.09.2001</b>
Name and mailing address of the international preliminary examining authority:   European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized officer  <b>Haegeman, M</b>  Telephone No. +31 70 340 2346  

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB00/01727

**I. Basis of the report**

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, pages:**

1-13 as originally filed

**Claims, No.:**

1-24 as originally filed

**Drawings, sheets:**

1/3-3/3 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB00/01727

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes: Claims 2, 4, 8, 13, 14, 19, 23, 24
	No: Claims 1, 3, 5-7, 9-12, 15-18, 20-22
Inventive step (IS)	Yes: Claims 13, 14, 19
	No: Claims 1-12, 15-18, 20-24
Industrial applicability (IA)	Yes: Claims 1-24
	No: Claims

2. Citations and explanations  
**see separate sheet**

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
**see separate sheet**

**Re Item V**

**Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Reference is made to the following document:

D1: DE19524490

2. The present application does not meet the requirements of the PCT, because the subject matter of independent claims 1, 7 and 15 is not new in the sense of Article 33 (2) PCT.

2.1. With respect to claim 1, D1 discloses:

A lift and strike welding process, wherein in a first step a first voltage is applied (see figure 1, from  $t=0$  to start of  $T_w$ ) so as to strike an arc between a stud, which is to be connected to a surface, and the surface, and wherein in a second step (after  $T_w$ ) the polarity of the first voltage is reversed and the stud is welded on by means of an arc struck by means of a second voltage.

Striking of an arc between the bolt and the surface will always burn off some of the dirt off the surface of the part to be welded. The cleaning during the first step is therefore considered to be implicitly disclosed.

D1 therefore discloses all the steps of the process of claim 1.

2.2. With respect to independent claim 7, D1 further discloses:

- an electric cleaning current flowing between a surface of a component and an element to be welded thereon, in that (see figure 1) the component rests on the surface and the element is then lifted off the surface to an approximately constant distance ( $S$  remains approximately constant during a large portion of the process time) for removing the coating from the surface using an arc as a cleaning agent,
- the current then changes its polarity, and a welding current is produced
- the element is then welded to the surface.

D1 therefore also discloses all the steps of the process of claim 7.

2.3. D1 also discloses an apparatus (see figure 3) having all the features of the independent apparatus claim 15

3. Dependent claims 2-6 8-12, 16-18 and 20-24 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step, the reasons being as follows:

3.1. D1 discloses all the additional features of claims 3,5-6, 9-12, 16-18, 20-22. These claims are therefore not new in the sense of Article 33 (2) PCT.

3.2. The additional features of claims 2, 4, 8, 23 and 24 present details or obvious additions or modifications to the process disclosed in D1, and can therefore not be considered as involving an inventive step in the sense of article 33 (3) PCT.

4. The combination of the features of dependent claims 13, 14 or 19 is neither known from, nor rendered obvious by, the available prior art.

#### **Re Item VII**

##### **Certain defects in the international application**

The Independent claims are not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art document D1 being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

#### **Re Item VIII**

##### **Certain observations on the international application**

1. Referring to a "First" lift and strike process in claim 1 and to a "Second" lift and strike process in claim 7, suggest these claims relate to two independent

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/GB00/01727

processes which is not the case.

This renders the claims vague and unclear and leaves the reader in doubt as to what is meant, thereby rendering the definition of the subject-matter of said claims unclear (Article 6 PCT).

2. The statement in the description on page 3, line 21 "It is advantageous when after the first step of applying the cleaning voltage , in a second step the polarity of the first voltage is inversed" implies that this is only optional, which suggests that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, III-4.3a).

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>GER 5355 (WO)</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/GB 00/ 01727</b>	International filing date (day/month/year) <b>05/05/2000</b>	(Earliest) Priority Date (day/month/year) <b>19/06/1999</b>
Applicant <b>EMHART INC.</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

## 1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☐ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☒ because this figure better characterizes the invention.

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☐ None of the figures.

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/01727

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 B23K9/20

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 195 24 490 A (EMHART INC) 9 January 1997 (1997-01-09) cited in the application	1-12, 15-18, 20-24
A	column 1, line 57 - line 60 column 3, line 42 - column 4, line 21 abstract; claims; figures	13, 14, 19
A	DE 43 13 502 A (BETTERMANN OBO OHG) 27 October 1994 (1994-10-27) column 4, line 38 - line 65 figure 7	1-24

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## ° Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

18 August 2000

Date of mailing of the international search report

25/08/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Haegeman, M

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International Application No

PCT/GB 00/01727

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19524490 A	09-01-1997	US 5938945 A	17-08-1999
DE 4313502 A	27-10-1994	NONE	